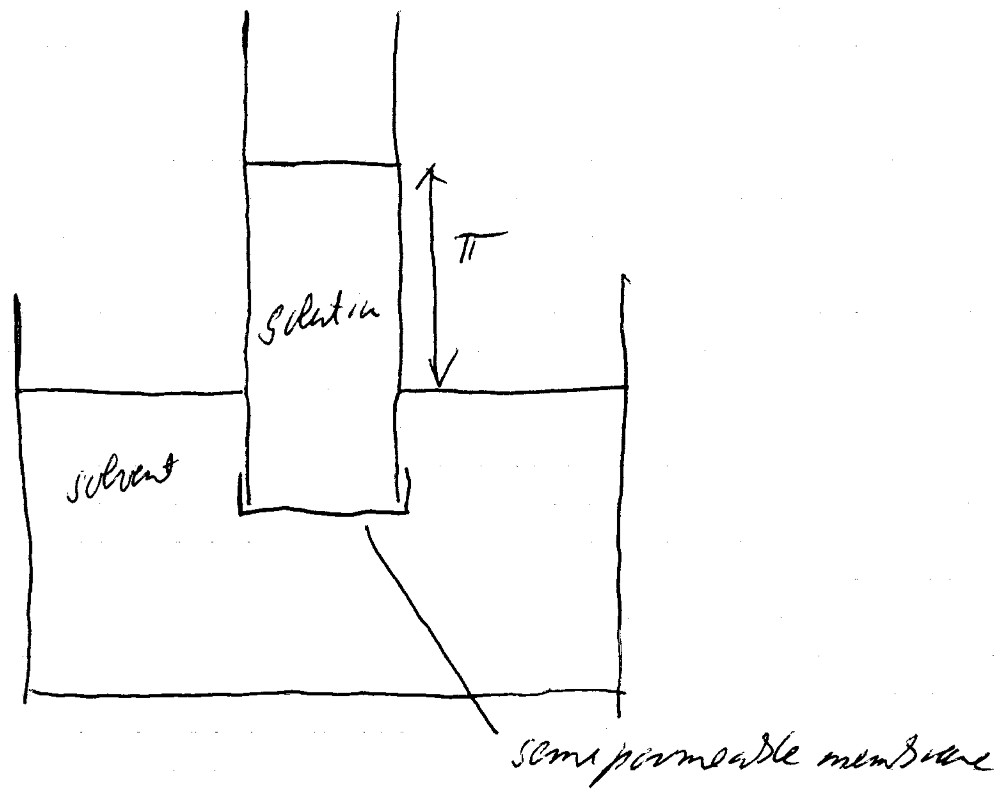
Osmosis



$$\mu_A^*(p) = \mu_A(X_A, p+\pi)$$

$$\mu_A(X_A, p+\pi) = \mu_A^*(p+\pi) + RT\ln X_A \qquad \text{(ideal)}$$

$$\mu_A^*(p+\pi) = \mu_A^*(p) + \int_p^{p+\pi} V_m \, dp$$

$$\rightarrow \; -RT\ln X_A = \int_p^{p+\pi} V_m \, dp$$

dilute: $\ln X_A = \ln(1-X_B) \simeq -X_B$, V_m p-independent

$$RT\, X_B = \pi V_m \qquad X_B \simeq \frac{n_B}{n_A} \qquad n_A V_m = V$$

$$\Rightarrow \boxed{\pi = \frac{n_B}{V} RT}$$ van't Hoff equation

Binding of small reagents to proteins

concentration of a protein or other macromolecule (= solute which cannot pass membrane). [M]

small solute A which can pass membrane and binds to M: $[A_{in}] = [A_{free}] + [A_{bound}]$

$$[A_{free}] = [A_{out}] \text{ — can be measured}$$

⇒ the average number of A molecules bound to M:

$$\nu = \frac{[A_{bound}]}{[M]} = \frac{[A_{in}] - [A_{out}]}{[M]} \leftarrow \text{measured}$$

(adjust for)

$$M + A \underset{K}{\rightleftharpoons} MA \qquad K = \frac{[MA]}{[M_{free}][A_{free}]} = \frac{[A_{bound}]}{([M] - [A_{bound}])[A_{free}]}$$

~~Multiple and independent binding sites~~

$$K = \frac{\nu}{(1-\nu)[A_{out}]}$$

~~Methods~~

Measurement of molecular masses of macromolecules:

for non-ideal solution

$$\Pi = RT\left(\frac{n_B}{V} + B\frac{n_B^2}{V^2}\right)$$

$$\Pi = \rho g h, \qquad \frac{n_B}{V} = \frac{c}{M} \qquad c\left[\frac{mg}{ml}\right]$$

$$\Rightarrow \frac{h}{c} = \frac{RT}{\rho g M}\left(1 + B\frac{c}{M} + \dots\right) =$$

$$= \frac{RT}{\rho g M} + \left(\frac{RTB}{\rho g M^2}\right)c + \dots$$

$\Rightarrow$ Plot h/c against c $\Rightarrow$
straight line intercepts for $c = 0$
at $\frac{RT}{\rho g M}$ $\Rightarrow$ M determined

Activities and non ideal solutions

solvent:

ideal + nonideal: $\mu_A = \mu_A^* + RT \ln \frac{p_A}{p_A^*}$

ideal ($\Leftrightarrow$ Raoult's law): $\mu_A = \mu_A^* + RT \ln x_A$

non-ideal: $\mu_A = \mu_A^* + RT \ln a_A$ $\quad a_A = \frac{p_A}{p_A^*}$

↑ equation for solvent! ↑ activity!

solute:

ideal + non-ideal: $\mu_B = \mu_B^* + RT \ln \frac{p_B}{p_B^*}$

ideal: $\mu_B = \underbrace{\mu_B^* + RT \ln \frac{K_B}{p_B^*}}_{=\mu_B^0} + RT \ln x_B$ (Henry's law)

real: $\mu_B = \mu_B^0 + RT \ln a_B$, $a_B = \frac{p_B}{K_B}$

Potential Exercises:

7.22, ~~7.12~~ 7.12, 7.19

Potential Problems

7.9, 7.19